3.1 HYDROLOGY AND GEOMORPHOLOGY

This section describes the hydrologic and geomorphic (land-form) conditions on and in the vicinity of the project site, including tidal action, surface water, runoff, flooding, groundwater flows and seepage, erosion, and sedimentation. Effects of the project and options on hydrologic and geomorphic resources are identified on the basis of studies conducted by Phillip Williams Associates (PWA, 2006), LSCE (2006), Hultgren-Tillis Engineers (2005), Natural Heritage Institute (2002, 2003, 2004), other reports including those for adjacent properties, and analysis of these reports by Wetlands and Water Resources (WWR), the chapter authors. Water quality is not addressed herein, but is described in detail in Section 3.2.

3.1.1 Affected Environment

Bay-Delta Estuary

The project is located in the Sacramento-San Joaquin Delta, within the upper reaches of the San Francisco Estuary. The Delta forms where the Sacramento and San Joaquin Rivers reach low-lying lands in the Central Valley, forming a maze of tributaries, sloughs, and islands that provide diverse habitats for plants and wildlife. From the rivers' confluence in the western Delta, they flow west through Suisun Bay and San Pablo Bay into central San Francisco Bay and through the Golden Gate into the Pacific Ocean. This entire system, from Delta to Golden Gate, comprises the San Francisco Estuary, the largest estuary on the West Coast of North and South America.

The Delta is a maze of river channels and diked islands covering roughly 1,150 square miles, including 78 square miles of water area (CVRWQCB 2004). The Delta receives runoff from about 40 percent of the land area of California, and about 50 percent of California's total streamflow (USGS 2000). It is the heart of a massive north-to-south delivery system, which transports billions of gallons per year of drinking water to more than 23 million people throughout the State (USGS 2000). The Sacramento and San Joaquin rivers collectively contribute roughly 95% of the total freshwater input to the estuary; the other 5% is provided by creeks and streams that drain directly into the Bay.

Hydrologic conditions in this area are affected predominantly by river flows, Marsh Creek watershed flows, diversions and other operations of the State Water Project and federal Central Valley Project, and tidal action. Agricultural diversions within the Delta may also contribute to local hydrology but at a minor scale.

Flows through the Delta vary greatly between seasons and from year to year. In a typical year, the Delta receives approximately 28 million acre feet (maf) of inflow from the watershed, with 75 percent of that coming from the Sacramento River, 15 percent from the San Joaquin River, and the rest coming from precipitation and the small eastern tributaries. About 25 percent of the Delta's inflow is pumped into the water supply system, predominantly to the State Water Project (only a very small fraction, 0.1 maf, to the Contra Costa Canal), and the rest flows into San Francisco Bay.

Flows within the Delta are extremely complex. The Delta consists of a network of branching, interconnected channels, which are strongly tidally affected. During periods of low surface water inflow, high tide events can effectively reverse the flow in some Delta channels. Dams in the upper watershed capture water and reduce flows during winter months and release water during summer months, increasing flows. A primary objective of the flow management regime is to reduce salinity intrusions from the Bay into the Delta by forcing the salt water out with freshwater flows (USGS 2000). Pumping water from the Delta into the State Water Project system in the south creates a southerly gradient within the channels of the southern portion of the Delta. Tidal effects in the vicinity of the Rock Slough and Old River intakes produce an oscillatory flow, which transports water back and forth in the channels, with a tidal elevation range of +/-3 feet at the Rock Slough intake (USGS 2000). In addition to tidal action and Delta inflows, the hydrologic conditions in the southern Delta channels are also influenced by municipal and agricultural water diversions and agricultural stormwater discharges.

Tides

OVERVIEW

San Francisco Bay Estuary is a "mixed-diurnal" tidal system, which generally exhibits two high tides and two low tides of unequal magnitude each day. During each tidal cycle (~24.5 hours) there is a higher high, high, low, and lower low tide. The heights of each high and low tide are different every day, reflecting the spring-neap tide cycle (~ 2 weeks tied to the moon's cycle) and seasonal controls. This tidal exchange is a fundamental determinant of water surface levels, direction, and volume of flow and salinity and thereby exerts a fundamental influence on the biological, chemical, and physical conditions of the Estuary.

Determining tidal datums at the site-specific scale involves collecting local water surface elevation data and comparing them to the NOS data for the closest continuous recording station. For Dutch Slough, the nearest NOS station is at Port Chicago located about 20 miles to the west. The calculated local tidal datum at Dutch Slough is presented in Table 3.1-1. This table includes Mean Higher High Water (MHHW), Mean High Water (MHW), Mean Low Water (MLW), and Mean Lower Low Water (MLLW) as these elevations inform restoration planning and design. PWA (2006) utilized two data sources to determine local tidal datums: work done in 2001 on Marsh Creek by Wetlands and Water Resources (WWR) for the Natural Heritage Institute and work done by the USGS between January 1, 1997 to February 28, 2003 in Dutch Slough. PWA calculated tidal datums using a one-year subset of the USGS data; they compared their results to those obtained by WWR and found similar results. The 100-year tide level included in Table 3.1-1 is based upon a FEMA estimate (1987).

TIDAL DATUMS AND SEA LEVEL RISE

Tidal datum refers to the local heights of the tides. Tidal datums vary spatially throughout the Estuary and Delta in response to complex processes of standing and progressive waves, interaction with local bathymetry, freshwater inflows, and atmospheric conditions. Tides decrease in amplitude and mean sea level increases from the Golden Gate into the Delta. Tide heights also increase over time with sea level rise. The National Oceanic and Atmospheric Administration's National Ocean Survey (NOS), the federal agency responsible for sea level monitoring and providing tidal data, periodically updates tidal datums to account for sea level rise; the most recent update occurred in 2003 for the five continuously measuring stations in the region and NOS continues to revise the numerous periodic stations around the region. That update showed a sea level rise of 0.2 ft at the Golden Gate between 1978 and 2003.

Tidal datums are projected to continue to rise as a result of global sea level rise. Global sea level rise can be a result of global warming through the expansion of sea water as the oceans warm and the melting of ice over land. Local sea level rise is affected by global sea level rise plus tectonic land movements and subsidence, which can be of the same order as global sea level rise. Atmospheric pressure, ocean currents and local ocean temperatures also affect local rates of sea level rise. The rate of global sea level rise is expected to continue along a global-warming-induced trajectory, possibly attaining an average rate of about 0.01 feet per year over the next 50 years (2000 to 2050), and rising to an average rate of about 0.015 feet per year over the following 50 years (2050 to 2100) (IPCC 2001). Although significant uncertainty exists regarding these rates, ongoing research regarding the primary factors affecting global sea level rise continues to narrow the uncertainties and refine future estimates.

For the purpose of this EIR, the Intergovernmental Panel on Climate Change (IPCC) mid-range estimate of 0.5 ft of future global sea level rise over the next 50 years was selected (IPCC 2001). The IPCC recently released an updated report (May 2007), which updates the 2001 global sea level rise estimates (IPCC 2007). The IPCC summary does not specify a 50-year mid-range estimate for direct comparison with the 2001 value. However, the midpoint of each of the 2007 climate change scenarios is within ten percent of the corresponding 2001 estimates (IPCC 2007).

The CALFED Independent Science Board (ISB) has evaluated the effects of sea level rise with respect to the Delta and concluded that current projections of sea level rise by the IPCC are likely very conservative as the models used to develop these projections under-estimate recent measured sea level rise (Jeffery Mount, ISB, memo to Mike Healy, CALFED, September 4, 2007). The ISB found that extrapolation from empirical models of sea level rise yields significantly higher estimates of sea level over the next few decades than the IPCC projections. The ISB suggests that the empirical projections are probably a better basis for short to mid term planning. The ISB further noted that neither approach to estimating future sea levels takes account of melting of ice in Greenland and Antarctica, which recent studies suggest is accelerating.

Based on their analysis, the ISB suggests that a mid range rise in sea level this century is likely to be at least 70-100 cm (27-39 inches), significantly greater (~200 cm/78 inches) if ice cap melting accelerates. Approximately one-third of the projected rise is expected in the next 50 years. While the absolute rise is alarming enough, even more alarming is the fact that only a few cm of sea level rise will greatly increase the frequency, intensity and duration of extreme water levels. It is these events that pose the greatest risk to Delta levees, infrastructure and private property.

Big Break

Big Break is located adjacent to the northwest boundary of the Emerson Parcel, across Marsh Creek. It is a former Delta tidal marsh diked in the late 1800s or early 1900s, farmed, and then subsequently breached by floods in the 1920s for which levee repairs were never made. The Big Break Regional Shoreline is managed by the East Bay Regional Park District. The site is predominantly open water, with perennial emergent freshwater marsh along its southern edges, and riparian species (*Salix* spp.) occurring near shore flats and low islands. Water from Dutch Slough and Marsh Creek passes through Big Break before entering the San Joaquin River.

Table 3.1-1. Dutch Slough Tidal Datums (from PWA 2006)

Tide Level	Dutch Slough Tidal Datums	
	Ft MLLW	Ft NGVD29
100-year tide level	6.8	6.5
Mean Higher High Water (MHHW)	3.44	3.15
Mean High Water (MHW)	2.99	2.7
Mean Sea Level (MSL)	1.77	1.48
Mean Tide Level (MTL)	1.76	1.47
Mean Low Water (MLW)	0.52	0.23
Mean Lower Low Water (MLLW)	0	-0.29

Sources: NOAA COOPS (2003), WWR (NHI, 2002) and FEMA (1987)

Dutch Slough

The principal surface waterway in the immediate Project vicinity is the east-west trending Dutch Slough, which connects Taylor Slough, Little Dutch Slough, Emerson Slough, and Marsh Creek. Dutch Slough separates Jersey Island to the north and the Project site to the south; it transports tidal flows between Franks Tract to the east and Big Break to the west. Dutch Slough receives water from the San Joaquin River and the myriad of rivers and channels in the southern portion of the Delta (see discussion of Sacramento-San Joaquin Delta, below), including Marsh Creek, Emerson Slough, Little Dutch Slough, Sand Mound Slough, Old River, and Middle River. Irrigation runoff from adjacent agricultural lands is also pumped over the levees and discharged into Dutch Slough. The direction of flow in Dutch Slough is controlled by the volume of flows from the Delta and tributaries, tidal cycles and, under some conditions, by pumping at the Rock Slough intake to the Contra Costa Canal (PWA 2006). A study by United States Geological Survey (Oltmann 1996) demonstrated the dynamic nature of tidal flows in the Delta, including Dutch Slough (Figure 3.1-1). As shown in the figure, flows at all stations changed direction with the tide, with the maximum flows in Dutch Slough reaching about 8,000 cubic feet per second (cfs) in either direction, about 16 times smaller than the San Joaquin River.

The direction of flow in Dutch Slough is determined primarily by tidal cycles. The direction and volume of flow also are influenced by pumping activities at the Rock Slough intake to the Contra Costa Canal. In addition to inflow from the Delta, pumps drain irrigation water from drainage ditches on adjacent properties into Dutch Slough. Dutch Slough also provides water via pumps for dry season irrigation and year round livestock use.

Little Dutch Slough and Emerson Slough

Little Dutch Slough and Emerson Slough are terminal sloughs that separate the Gilbert and Burroughs parcels and Emerson and Gilbert parcels, respectively. Little Dutch Slough receives a small amount of local watershed runoff and pumped agricultural drainage from diked lands south of the Contra Costa Canal.

The geomorphology of Little Dutch Slough, Emerson Slough, and their associated tributaries has been strongly influenced by human activities. When diking and agricultural activities in the area commenced in the late 1800s, the formerly sinuous tidal creeks were straightened and surrounded by earthen levees.

The Little Dutch Slough channel widens and deepens as it approaches Dutch Slough. The channel is approximately 100 feet wide in its southern reach near the Contra Costa Canal, widening to approximately 300 feet at the mouth of the slough. Channel invert (bottom) elevations slope downward from -2 ft NGVD[1]29 near the Contra Costa Canal to -7 ft NGVD29 at the mouth of the slough. Emerson Slough also shows widening and deepening from south to north, with southern and central cross sections being roughly 150 feet wide and 10 to 15 feet deep. To the north near its confluence with Dutch Slough, Emerson Slough widens to about 230 feet wide and 18 feet deep (NHI 2004).

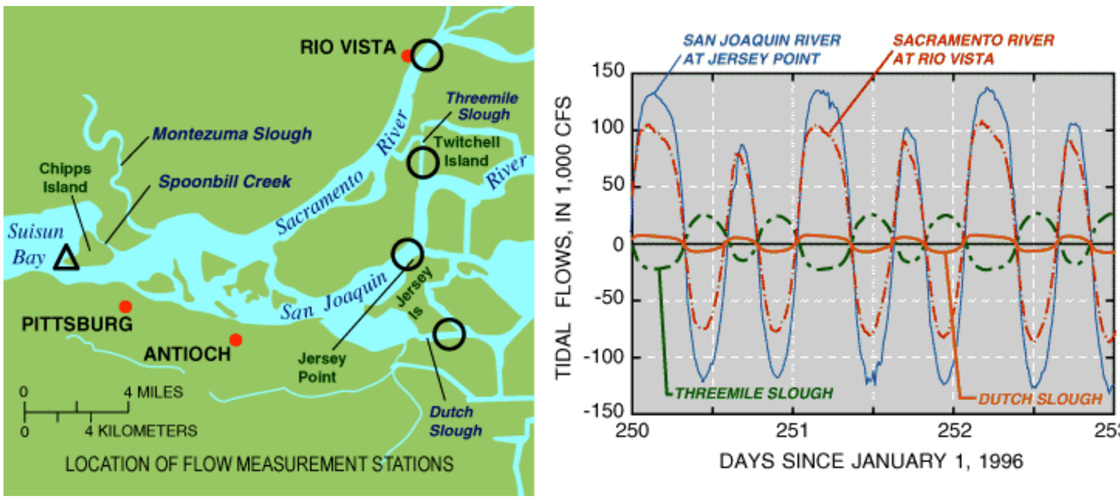

Figure 3.1-1. Flow directions and magnitudes at four stations in the Sacramento-San Joaquin Delta. Positive flow indicates seaward flows except for Threemile Slough, where positive flow indicates flow from the Sacramento River to the San Joaquin River. Source: Oltmann 1996; USGS

Marsh Creek Delta

Historically, Marsh Creek meandered across its lower reach, depositing mineral sediments and building natural levees until storm events forced it to leave its banks and establish a new channel. Through this process the creek gradually formed a delta at its mouth and the location of the creek's confluence with Dutch Slough varied over time. Confinement of the creek into its existing flood control channel took this ability away from the creek, and the location of its delta is now controlled by human flood control activities. Aerial photos taken in 1968 and 1978, indicate that at some point between those dates the mouth of the creek changed from flowing directly into Dutch Slough to flowing straight into Big Break.

Contributing Watersheds

Dutch Slough spans the boundaries of two watersheds. The western parcel (Emerson Parcel) is in the large Marsh Creek watershed while the middle and eastern parcels (Gilbert and Burroughs) are in

[1] NGVD29 29 = National Geodetic Vertical Datum of 1929. See http://www.ngs.noaa.gov/faq.shtml for more information.

the small East County Delta Drainages watershed (Jones and Stokes 2005). The Ironhouse Parcel is also part of the Marsh Creek watershed.

MARSH CREEK HYDROLOGY

Marsh Creek flows approximately 30 miles from its headwaters in the upper eastern portions of Mt. Diablo to its mouth at Big Break. The 128-square-mile watershed includes undeveloped and agricultural uplands in the upper watershed and urban lowlands in the vicinity of Brentwood and Oakley (Figure 2-1). Marsh Creek Reservoir, located in the upper portion of the watershed near Briones Valley, was constructed in 1938 and stores runoff from approximately 38% of the watershed (PWA 2006). The four major tributaries draining into Marsh Creek are Briones, Dry, Deer and Sand Creeks. The confluence of Briones and Marsh Creeks is at the Reservoir while Dry, Deer, and Sand Creeks flow into Marsh Creek in the lower portions of the watershed.

Rainfall in the watershed is comparatively light because of the rain shadow effect of Mt. Diablo. Average annual rainfall at Brentwood for the period 1907 to 2000 is 12 inches with variation between 4 and 30 inches (NHI 2003). Flow in Marsh Creek is highly seasonal, with peak flows associated with winter storm runoff, though it flows year round with summer flows sustained by discharges from the Brentwood Wastewater Treatment Plant. The 100-year flow is estimated to be 2,720 cubic feet per second (cfs) at its mouth at Big Break (CCC 2003). The lower reach of Marsh Creek, on the Project site, approximately north of its crossing the Contra Costa Canal, is tidal-influenced except during brief periods (generally less than one week annually) during the winters of wet years with high Delta outflow (PWA 2006). Bypasses and overbank spills upstream of the Contra Costa Canal are estimated to reduce peak flood discharges in lower Marsh Creek relative to locations further upstream (PWA 2006, FEMA 1987). Tidal height (stage) in Dutch Slough controls flood elevations in lower Marsh Creek below the Contra Costa Canal (PWA 2006). The lower reach of Marsh Creek in the project vicinity is owned by the Contra Costa County Flood Control and Water Conservation District, which maintains the channel for flood conveyance purposes.

MARSH CREEK GEOMORPHOLOGY

Before the Natural Resource Conservation Service (formerly the Soil Conservation Service) commenced flood control activities in eastern Contra Costa County in the 1950s and Reclamation District 799 began constructing levees in the area in the early 1900s, Marsh Creek meandered freely across the alluvial plain and into the diked lands adjacent to the project reach. However, these levee building and flood control activities had a major impact on Marsh Creek and its tributaries by straightening and confining the creeks as they moved through the developed lowlands. Marsh Creek was isolated from its floodplain and almost all natural features such as vegetation, point bars, riffles, and pools were removed. The channel was re-graded into an enlarged, homogenous, trapezoidal cross-section to expedite the movement of flood flows into Dutch Slough. The flood control channel separates the Dutch Slough site on its east from the Ironhouse parcel on its west, and is bordered on either side by levees that confine the entire flow of Marsh Creek. The elevation of the levees ranges from +12 to +14 feet NGVD29. The flood control district employs a chemical mowing program along the channel and levee banks to prevent colonization of riparian vegetation and maintain flood conveyance capacity. The levee on the west bank north of the EBRPD bridge, dividing Marsh Creek from Big Break, is not maintained.

EAST COUNTY DELTA DRAINAGES

The Gilbert and Burroughs parcels are linked to small portions of the East County Delta Drainages. These low-lying lands are dissected by numerous agricultural drainage ditches often terminating in pumps that discharge stormwater and groundwater into tidal sloughs. Flow in these areas is largely controlled by flood control infrastructure and irrigation canals which crisscross the landscape to supply water for agriculture (CCWD 2003).

Contra Costa Canal

Immediately south of the Dutch Slough site is the Contra Costa Canal, an artificial earth-lined waterway that supplies water from the Delta at Rock Slough to the Contra Costa Water District (CCWD) Pumping Plant No. 1 located a short distance southwest of the site. The canal from the pumping plant east to Rock Slough is approximately 4 miles in length, 10 feet deep at mean tide, and 50 to 100 feet wide (CCWD 2006). Top elevations of the levee on the north side of the Canal adjacent to the Project site range from +8.3 to +24.4 ft NGVD29. A trash rack and headworks structure are located at the Canal's confluence with Rock Slough. CCWD uses this water intake during winter months only as needed to supplement other water supply sources. CCWD maintains and operates the Contra Costa Canal for the U.S. Bureau of Reclamation, which owns the canal and adjacent right-of-way (ROW). Maintenance along the unlined canal ROW includes discing, mowing, and the use of herbicides and aquatic pesticides. CCWD expects that maintenance along the unlined canal would increase as more houses are built close to the canal (CCWD 2006).

CCWD is currently proposing to encase the canal in a pipeline from Rock Slough to Pumping Plant No. 1 (CCWD 2006). Phase I of the encasement, which encompasses the portion of the Canal between Pumping Plant No. 1 and the west side of Marsh Creek (approximately 2,000 feet), is scheduled to begin in April 2008. Encasement of the canal would eliminate its connectivity to surrounding surface and ground water, thereby eliminating concerns related to groundwater intrusion to the canal from the Dutch Slough Restoration Project. The Canal Encasement project has not received final permits.

Groundwater Connectivity to Surrounding Properties

Sand underlies the Dutch Slough site and adjacent properties in all directions with typical depths extending 30 to 50 feet below ground surface (Hultgren-Tillis 2005). While the regional groundwater gradient is from south to north toward the tidal waters of the western Delta, pumping and other land use activities on individual properties locally modify this gradient (Hultgren-Tillis 2005). Groundwater depths on the Dutch Slough site vary seasonally and between the parcels. During a recent study from September 2004 to April 2006, LSCE (2006) reported ranges of -0.7 to +5.7 ft NGVD29 on the Emerson Parcel, -1.5 to +3.2 ft NGVD29 on the Gilbert Parcel, and -2.7 to +1.5 ft NGVD29 on the Burroughs Parcel; LSCE reported all its data in feet NAVD88 which we have converted to NGVD29 to be consistent with the datum used in the Feasibility Report (PWA 2006)[2]. That conversion is approximately a 2.7ft difference locally. The Dutch Slough parcels are behind levees, subsided, and experience regular groundwater pumping, especially in the winter to maintain

[2] NAVD 88 = North American Vertical Datum of 1988, which supersedes the National Geodetic Vertical Datum of 1929. The local difference between the two is estimated to be 2.7 ft per National Geodetic Survey online software at http://www.ngs.noaa.gov/TOOLS/Vertcon/vertcon.html. See http://www.ngs.noaa.gov/faq.shtml for more information.

accessible land (Hultgren-Tillis 2005). All the recent groundwater monitoring data demonstrate a daily tidal influence of roughly 0.1 to 0.2 feet (LSCE 2006).

CONNECTION TO THE CONTRA COSTA CANAL

DWR and CCWD recently released an evaluation of the relationship between shallow groundwater in the restoration area and the Contra Costa Canal *(Groundwater Investigation and Monitoring Program, Dutch Slough Restoration Area,* LSCE 2006). This study included (1) installing six monitoring wells 25 feet in depth (two on the Emerson Parcel, two on the Gilbert Parcel, one on the Burroughs Parcel, and one south of the Canal opposite the Gilbert Parcel) and monitoring their water level hourly from September 2004 to April 2006, (2), installing one stilling well in Emerson Slough and monitoring tide stage hourly from September 2004 to March 2005 and utilizing DWR monitoring data from Rock Slough after March 2005, and (3) sampling the monitoring wells and surface water in the Canal, Marsh Creek, Emerson Slough, and the Gilbert Pond and analyzing samples for a suite of mineral and nutrient water quality indicators.

The study indicated three general trends in the region. First, groundwater generally flows from south to north, i.e., from the low-lying alluvial plain of the lower watershed to the Delta. As noted above, management on individual parcels north and south of the canal, most notably winter pumping and summer irrigation, mediate these regional flow patterns at the site scale. Second, local soils generally exhibit relatively high permeability, facilitating groundwater exchange with surface water. This permeability is evident from the groundwater data at all six monitoring wells, as water levels exhibit a daily tidal signal (water levels rise and fall with the tides) on the order of 0.1 to 0.2 feet from adjacent tides in Marsh Creek, Dutch Slough, or the Contra Costa Canal.

For the Emerson and Gilbert Parcels, the study found that hydraulic conditions favor net flow from groundwater into the Canal during wet periods (termed “discharge”) and from the Canal into groundwater during dry periods (termed “recharge”). Periodically, summer irrigation activities raise groundwater levels on these parcels higher than water surface elevations within the Canal, creating the potential for temporary groundwater flow into the Canal. Otherwise, summer conditions favor outflows from the Canal (groundwater recharge). (LSCE 2006) At the Burroughs Parcel, the study found year-round flux from the Canal (recharge).

The LSCE study used a 5-hour averaged tide stage at Rock Slough as the tidal reference elevation. This approximation of mean sea level ranged from about 0.5 to 2.6 ft NGVD29, with the average value over the study period of about 1.3 ft NGVD29. Mean sea level at the Dutch Slough site is about 1.5 ft NGVD29; see Table 3.1-1.

For salt loading into the Canal, the study found results similar to prior investigations mentioned but not cited in the LSCE report, namely, that the Canal accumulates salts during low- and no-flow periods that originate from a broad source or sources of dissolved salts available in the vicinity of the unlined portions of the Canal. The report identifies these sources to include soils, seawater intrusion, wastewater application, and agricultural runoff. The study confirmed the Dutch Slough site groundwater to be generally brackish. The study also noted that two predominant soil types in the area, Marcuse Clay and Sycamore Silty Clay Loam, are characterized as poorly drained, saline, and alkali by the NRCS. The study did not attempt to identify the relative contributions of these different sources of salt but it did indicate the groundwater discharge from the south is expected to be greater than from the north (Dutch Slough site) side of the Canal, based on the regional groundwater gradients.

Previous investigations (mentioned but not cited in LSCE [2006]) of groundwater conditions at the Ironhouse parcel carried out by the Ironhouse Sanitary District have encountered groundwater elevations higher than water elevations in the Canal during certain periods. The District has also observed degraded water quality in the Canal during wet periods. Hultgren-Tillis (2005) reported groundwater levels were typically around local mean tide level and were controlled by irrigation from the Sanitary District and from groundwater connectivity to Marsh Creek.

CONNECTION TO LANDS SOUTH OF THE CONTRA COSTA CANAL

A stormwater management plan produced for the property immediately south of the Canal across from the Emerson parcel (Balance Hydrologics 2004) describes persistent groundwater elevations along the northern boundary of this property around +2.0 ft NGVD29, although no data are given to support this assertion. Data collected between September 2004 and April 2006 on the property south of the Gilbert Parcel (at a location approximately 400 ft south of the Canal) showed groundwater levels between about -0.7 to +3.3 ft NGVD29 with higher levels in the winter and lower levels in the summer (LSCE 2006).

CONNECTION TO LANDS EAST OF JERSEY ISLAND ROAD

ENGEO Inc (2005), which conducted a study for the adjacent Cypress Corridor Specific Plan Area (CCSPA) east of Jersey Island Road, concluded that that Emerson and Little Dutch Sloughs "do not currently contribute to significant groundwater recharge in [the CCSPA] because drainage tiles and lift pumps used to dewater the lands below sea level exist adjacent to these sloughs that provide a point of hydraulic control with zero net effect. In other words, the amount of water recharges from the sloughs equals, or is less than, the amount of water being removed by the drainage tiles and drainage lift pumps." The same study also concludes that the Contra Costa Canal recharges groundwater in the CCSPA because water surface elevations in the Canal are typically higher than groundwater elevations. ENGEO (2005) estimated the amount of this recharge to be approximately 335 acre-feet per year. Hultgren-Tillis (2005) indicated that recharge from Dutch Slough via porous underlying sandy soils contributes to groundwater in these lands.

CONNECTION TO LANDS WEST OF MARSH CREEK

Across Marsh Creek from the Dutch Slough site are ISD lands on which treated wastewater is used to irrigate fields and, as such, the land's available capacity for receiving water inputs is fully committed. Existing groundwater levels on these Ironhouse lands are around mean tide level. Marsh Creek is likely to be a drainage boundary between the Ironhouse lands and the Dutch Slough site (Hultgren-Tillis 2005).

Flooding

The three Dutch Slough parcels and the Ironhouse parcel are within FEMA's 100-year floodplain, which has a base flood elevation of +7 feet NGVD29 (PWA 2006; FEMA 1987). The agricultural levees around Dutch Slough and in the surrounding vicinity are not constructed to FEMA standards, and as such are presumed inadequate for providing 100-year flood protection. The berm separating the Contra Costa Canal from the Dutch Slough site has top elevations above the 100-year flood level and the FEMA study indicates it will provide protection to the lands south of Dutch Slough, even though it was not engineered for this purpose. However, PWA (2006) reports that site topographic surveys identify breaks in the embankments near Emerson and Little Dutch Sloughs that could result in flooding to the south. In addition, CCWD is planning to encase the entire canal by placing it an underground pipe. When this is done, the berm will be graded down to a lower elevation.

On site and surrounding infrastructure that may be susceptible to flood impacts include (PWA 2006):

- The Ironhouse Sanitary District Pipeline located along the northwest corner of the site
- The active gas wells located on the Burroughs property
- The Pacific Gas & Electric power lines located on the northeastern corner of the site
- The adjacent levees, including the Jersey Island levees north of Dutch Slough, could experience wave-induced erosion.
- The 1.36-acre residential inholding on the Burroughs parcel, adjacent to Jersey Island Road
- The proposed 55-acre City park site
- Areas south of the site that drain into Emerson Slough and Little Dutch Slough

Emerson, Gilbert, and Burroughs Parcels Hydrology

The Emerson, Gilbert, and Burroughs parcels collect direct precipitation and are seasonally managed during the rainy season, with surface water gathered in agricultural drainage ditches and pumped into the surrounding sloughs (PWA 2006). The existing groundwater elevation in the Dutch Slough site is estimated to be between +3 feet to -10 ft NGVD29 (PWA 2006). The existing levees around the Dutch Slough Restoration Project site have allowed the groundwater to be artificially lowered within the project site by evapo-transpiration in the summer and pumping in the winter. Many adjacent levee-protected properties also have lower groundwater levels than existed prior to reclamation. The aquifer beneath the site is being recharged in part from Dutch Slough, Little Dutch Slough, Emerson Slough, and the Contra Costa Canal. Groundwater levels around the site vary irregularly, most likely due to local groundwater withdrawal and/or infiltration. Regional topography and geology may cause a general pattern of groundwater flow in a northerly direction; however, local modifications to groundwater levels are likely to have a greater influence on the direction and magnitude of groundwater flow than regional patterns (PWA 2006).

Emerson, Gilbert and Burroughs Parcels Topography

PWA compiled previously existing site topographic data in the Dutch Slough Conceptual Plan & Feasibility Report (PWA 2006). Dutch Slough is more suitable for tidal marsh restoration than most other potential restoration sites in the Delta because it is not deeply subsided and sizeable portions of the site are at elevations conducive to sedimentation and colonization of emergent tidal marsh vegetation (PWA 2006). Table 3.1-2 presents the parcel acreages at the Dutch Slough parcels relative to the local tidal datum. These data are based upon previous site topographic surveys conducted by Carlson, Barbee & Gibson (CBG) and Green Mountain Engineering (GME) and the tidal datums reported in Table 3.1-1.

CBG conducted an aerial photogrammetric survey in 2000 to characterize site topography; this data set is reported relative to NGVD29. GME conducted subsequent ground surveys of the Emerson and Gilbert parcel levees in 2004. Characterizing site elevations relative to the tidal datums is important as it informs the restoration design, the location of design features and the overall feasibility of the restoration. These parcels slope downward from south to north (See Figure 2-3). Elevations at the site range from approximately -10 to +15 feet NGVD29 (-12 to +13 feet MSL) (PWA 2006). Most of the site (~68%) is below MLLW. Levee top elevations on the Gilbert, Burroughs and Emerson parcels range from ~ +8 to +12 feet NGVD29, though the southwestern portions of the Emerson parcel adjacent to Marsh Creek are substantially higher (+10 to +24 feet NGVD29) to provide greater flood protection along Marsh Creek.

Table 3.1-2. Parcel acreages relative to Dutch Slough tidal datums (from PWA 2006).

Elevation Range	Emerson (acres)	Gilbert (acres)	Burroughs (acres)
5 ft. above MHHW to Highest (Potential Dune Habitat and Upland)	32	1	3
MHHW to 5 ft above MHHW (Potential Riparian)	133	33	31
MTL to MHHW (Potential High Emergent Marsh)	22	17	37
MLLW to MTL (Potential Low Emergent Marsh)	12	6	27
6.25 ft. below MLLW to MLLW (Potential Low Emergent Marsh and Shallow Subtidal)	126	197	299
Lowest to 6 ft below MLLW (Potential Deep Subtidal)	111	21	21
Total	436	275	418

Note: Potential habitats based on colonization elevation data from Orr and others, 2003. Total acreages differ from the totals in NHI, 2004 due to small differences in the digitized boundaries.

Ironhouse Parcel Hydrology and Topography

The Ironhouse Parcel consists of 100 acres of irrigated pasture owned by the Ironhouse Sanitary District. The sanitary district irrigates the pasture with treated wastewater. The average elevation of the pasture is +6 feet NGVD29. The site is currently bisected by the Contra Costa Canal, which constrains the course of Marsh Creek where the two cross. As discussed above, groundwater elevations in the Ironhouse parcel can at times exceed surface water elevations in the Canal, creating conditions amenable to net flow from groundwater into the Canal. Hultgren-Tillis (2005) reported groundwater levels were typically around local mean tide level and were controlled by irrigation from the Sanitary District and from groundwater connectivity to Marsh Creek. The Contra Costa Water District is proposing to encase the canal below the lowest elevation of Marsh Creek and fill in the existing canal. The canal encasement and fill project would effectively eliminate any surface expression of the canal across the Ironhouse Parcel.

Regulatory Setting

Contra Costa County

The specific regulatory considerations related to hydrology and geomorphology are those arising from the Contra Costa County Flood Control and Water Conservation District (CCCFCWCD) and its obligations relative to maintaining flood conveyance capacity of Marsh Creek. Since the District owns Marsh Creek in fee title, any work proposed on the creek would require a flood control encroachment permit.

If Marsh Creek is diverted into the Dutch Slough site such that the original channel north of the diversion does not provide flood control services, CCCFCWCD has no interest in retaining the "orphaned" right-of-way along that segment of the channel. As a result, work on Marsh Creek may require real property transactions between CCCFCWCD and DWR.

At a minimum, CCCFCWCD would require that the project "design and construct a drainage system to adequately collect and convey stormwater runoff, entering or originating within the project to the nearest natural watercourse or adequate man-made drainage facility, without diversion of the watershed" (CCCFCWCD 2006). The design flow for the Marsh Creek flood control channel is the typical FEMA 100-year flow. The CCCFCWCD has requested that any Marsh Creek relocation efforts include as the design basis the flow of a 100-year storm based on ultimate watershed development (CCCFCWCD 2006).

Natural Resource Conservation Service

The Marsh Creek channel/levees were originally constructed by the Soil Conservation Service (SCS), now the Natural Resource Conservation Service (NRCS). Major modifications to the Marsh Creek channel/levees may need to be approved by NRCS. The NRCS also may need to release right-of-way transfers of portions of Marsh Creek to other agencies.

The State Reclamation Board cooperates with federal and State agencies and local governments in establishing, planning, constructing, operating, and maintaining flood control works. Reclamation District 799 is the agency responsible for flood protection and drainage on the Hotchkiss Tract immediately east of the Dutch Slough site. The Reclamation District issues permits for projects that:

A. Are within federal flood control project levees and within a Board easement, or

B. May have an effect on the flood control functions of project levees, or

C. Are within a Board designated floodway, or

D. Are within regulated Central Valley streams listed in Table 8.1 in Title 23 of the California Code of Regulations.

CALFED Delta Risk Management Strategy

A major need for the State is to determine how to make the Delta sustainable in the future. The 2000 CALFED Record of Decision presented its Preferred Program Alternative that described actions, studies, and conditional decisions to help fix the Delta. Included in the Preferred Program Alternative for Stage 1 implementation was the completion of a Delta Risk Management Strategy

(DRMS) that would look at sustainability of the Delta, and that would assess major risks to the Delta resources from floods, seepage, subsidence, and earthquakes. DRMS has also evaluated the consequences, and develop recommendations to manage the risk. To implement the Delta risk assessment, legislation was passed that requires DWR to evaluate the potential impacts on water supplies derived from the Delta based on 50-, 100-, and 200-year projections for each of the following possible impacts: subsidence, earthquakes, floods, climate change and sea level rise, or a combination of the above. The DRMS work will provide the majority of this required information. The report is due to the Legislature no later than January 1, 2009.

3.1.2 Impacts and Mitigations

Significance Criteria

Significance Criteria for the relevant hydrology and geomorphology portions of the project are based upon the CEQA guidelines and professional judgment. Potentially significant impact could occur if the project results in:

- Substantial modifications to existing hydrological conditions, including surface water inputs and outputs, drainage network, or channel alignment resulting in substantial erosion or siltation on or off-site
- Substantial modifications to existing infiltration rates and interference with groundwater recharge that would deplete groundwater supplies or lower the local groundwater table level
- Substantial alterations to existing drainage pattern of the project site or area that would increase surface runoff resulting in on-site or off-site flooding
- Runoff that would exceed stormwater drainage systems or act as source of polluted runoff
- Structures placed within a 100-yr flood hazard area that would impede or redirect flood flows
- Exposure of people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of levee failure

Alternative 1: Minimum Fill

IMPACT 3.1.1-1 EROSION IN TERMINAL SLOUGHS DUE TO INCREASED TIDAL PRISMS

DUTCH SLOUGH RESTORATION PROJECT AND RELATED PROJECTS

Due to the presence of the site's perimeter levees, the tidal prisms (the tidal prism is the volume of water that flows past a given point, such as through a levee breach, during a tidal cycle) currently carried by Emerson and Little Dutch Sloughs are substantially smaller than they would be if the perimeter levees were breached. The channel geometry of these terminal sloughs is sized to carry these smaller tidal prisms. As a result, with the Project, it is expected that the sloughs would erode over time to accommodate the larger post-restoration tidal prisms (PWA 2006).

Erosion in and of itself would not be an undesirable impact of the Project; it would suspend a local sediment source in the tidal water column, making this sediment available for deposition on the restored marsh plain. However, erosion can result in negative impacts if (1) it does not happen within an expected period of time, resulting in a muted tidal signal which can potentially delay marsh plain evolution (PWA 2006), (2) it threatens the integrity of the upland areas surrounding the proposed City Community Park (Emerson Slough) or the berm adjacent to the Contra Costa Canal (Little Dutch Slough), or (3) it results in local water quality impairments.

Erosion Time Frame. The impact of erosion in Little Dutch Slough was modeled in 2006 by PWA, however, the modeling assumed the moderate site fill of Alternative 2, not the minimal fill of Alternative 1. The tidal prisms under Alternative 1 are larger than those of Alternative 2 due to lower total fill volumes to reverse subsidence. For the purposes of this analysis, it is assumed that the results of the Little Dutch Slough modeling apply to Emerson Slough as well. The modeling determined that velocities in the slough would be within the range of scouring (eroding) velocities, though the actual rates/amounts of scour could not be estimated due to a lack of information about critical shear stress values of the sediments in the slough. If modeled flow velocities were within scouring range under the smaller tidal prisms of Alternative 2, it follows that modeled velocities would be even higher for the larger tidal prisms of Alternative 1.

Since it is expected that erosion would occur, whether or not it happens within an "expected" time frame is dependent on the project performance measures established by project planners.

Upstream Erosion. Under Alternative 1, all breaches to the Dutch Slough Restoration Project site are downstream of the uplands south of Little Dutch Slough and the proposed City Community Park near Emerson Slough. Since the tidal prism upstream of these breaches would remain virtually unchanged, significant erosion in these areas is not anticipated.

OPEN WATER MANAGEMENT OPTIONS

The amount of erosion in the terminal sloughs is directly related to the size of the site's tidal prism. The larger the tidal prism, the greater erosion would be. Therefore, erosion would likely be greatest under the deep subtidal option, less so under the shallow subtidal option, and even less so under the skeletal channel network option. The PWA modeling indicates that if channel geometry in Little Dutch Slough remains unchanged, managing the open water areas as non-tidal would cause tidal damping to be slightly less than if the areas were fully tidal. Less tidal damping would likely result in increased erosion due to higher scouring velocities. Subsidence reversal is unlikely to result in the deposition of enough material to have a short-term significant effect on tidal prisms and scouring velocities in the terminal sloughs; this outcome may change in the long-term if plant material accretes to intertidal elevations.

"NO BURROUGHS" OPTION

Under this option, the levee breaches would occur on Emerson Slough rather than Little Dutch Slough. For the purposes of this analysis, it is assumed that the results of the Little Dutch Slough modeling apply to Emerson Slough as well. Therefore, the impacts of and proposed mitigations for the "no Burroughs" option with breaches on Emerson Slough are the same as for the tidal restoration of all three parcels with breaches on Little Dutch Slough

MITIGATION 3.1.1-1.1 EROSION/SEDIMENTATION DESIGN AND PERFORMANCE STANDARDS

The final design of the restoration projects shall include design periods, performance standards, and adaptive management contingencies for site evolution and development.

MITIGATION 3.1.1-1.2 EROSION MONITORING AND ADAPTIVE MANAGEMENT

Continual monitoring of erosion in the terminal sloughs shall be conducted by the Project for at least 10 years post-construction. This will not only provide useful scientific data, but also will allow for adaptive management of the Restoration Project site. If erosion is so great that it causes water quality impairments (see Section 3.2), improvements such as channel armoring shall be implemented to manage and reduce erosion.

IMPACT SIGNIFICANCE AFTER MITIGATION

Less than significant with mitigation.

IMPACT 3.1.1-2 DECREASED FLOOD FLOW CONVEYANCE OF MARSH CREEK DUE TO INCREASED TAILWATER ELEVATIONS (IRONHOUSE PROJECT ONLY)

Flood flow conveyance in Marsh Creek is controlled by a number of factors: fluvial flows, tidal flows, channel geometry, bed roughness factors such as vegetation and shellfish, and flow attenuation via on- and off-line reservoirs and detention basins. Tidal influence on Marsh Creek is greatest near its mouth at Dutch Slough, then decreases heading upstream (NHI 2002). While the elevations of MLW and MLLW in the creek are controlled partially by bed elevations, MHHW in the creek near the Contra Costa Canal is only 0.2 ft lower than MHHW at the mouth of Marsh Creek. This small amount of tidal dampening is due to the larger dimensions of the channel north of the existing EBRPD bridge (NHI 2002). If the tidal prism upstream of the mouth of Marsh Creek is increased due to restoration of the Ironhouse parcel, tides may become muted and/or perched upstream in Marsh Creek. Given this increased tidal action further south towards and beyond the Contra Costa Canal, the project could be expected to increase tailwater height. WWR expects the existing 0.2 ft difference between MHHW at the Marsh Creek mouth and the Contra Costa Canal to shift south of the Canal and to propagate further upstream along Marsh Creek. While the effects of higher tailwater elevations on flood conveyance in Marsh Creek have not yet been evaluated, the effects are unlikely to be significant because the anticipated tailwater elevation increase (0.2 ft) is so small. Nevertheless, the risk of flooding around Marsh Creek makes modeling these effects prudent (see Mitigation Measures).

MITIGATION 3.1.1-2.1 DEVELOP DESIGN CRITERIA FOR INCREASED TIDAL PRISM ON MARSH CREEK

Prior to implementing restoration of the Ironhouse parcel a hydrodynamic analysis of the creek and/or the proposed Ironhouse restoration shall be performed, as applicable. This analysis shall investigate water surface elevations, flow rates/velocities, and groundwater impacts within lower Marsh Creek and its adjacent properties. On the basis of this analysis design criteria shall be developed that eliminate any potential for increased flooding from changes in tidal prism generated by restoration of the Ironhouse parcel (see Mitigation 3.1-2.2, below).

MITIGATION 3.1.1-2.2 DESIGN MARSH CREEK TO CONVEY 100-YEAR DESIGN FLOW

Any channels built to route Marsh Creek shall be designed and constructed to have adequate capacity convey the creek's 100-year design flow rate, as determined by the CCFCD.

IMPACT SIGNIFICANCE AFTER MITIGATION

Less than significant with mitigation.

IMPACT 3.1.1-3 PEAK FLUVIAL-TIDAL DEPOSITION (IRONHOUSE PROJECT ONLY)

Due to increased tailwater elevations in Marsh Creek from restoration of the Ironhouse parcel (see Impact 3.1.1-2 above), the point of peak tidal-fluvial deposition in the creek would move south (upstream). However, insufficient information exists to determine the magnitude and location of these depositional changes. From a qualitative perspective, considering the anticipated small (0.2 ft) increase in MHHW throughout the lower reach of Marsh Creek, WWR expects the depositional changes to be less than significant. The Contra Costa County Flood Control District may have to shift the location, extent, and frequency of channel bed dredging as a consequence of this project, but it is not expected to result in a significant change to dredging needs.

IMPACT 3.1.1-4 POTENTIAL INCREASED FLOODING AT THE IRONHOUSE PARCEL (IRONHOUSE PROJECT ONLY)

Wetland restoration at the Ironhouse parcel would involve the breaching of a Marsh Creek levee (top elevation +12 to +14 ft NGVD29) and the excavation of lands at about +6 ft NGVD29 to about +1.5 ft NGVD29. Soil material excavated from the Ironhouse parcel will be used as fill in the greater Dutch Slough Restoration Project. Flood protection to compensate for breaching of the Marsh Creek levee would be provided by construction of a flood control levee around the upland edge of the parcel.

MITIGATION 3.1.1-4 CONSTRUCT FLOOD PROTECTION LEVEE AROUND IRONHOUSE PARCEL (APPLIES TO IRONHOUSE PROJECT ONLY)

To match the existing level of flood protection around Marsh Creek, a new flood control levee shall be built around the restored Ironhouse parcel. A flood protection analysis shall conducted in coordination with CCCFCD to determine the appropriate height for this levee.

IMPACT SIGNIFICANCE AFTER MITIGATION

Less than significant with mitigation.

IMPACT 3.1.1-5 POSSIBLE WATER QUALITY DEGRADATION IN CONTRA COSTA CANAL DUE TO GROUNDWATER SEEPAGE

DUTCH SLOUGH RESTORATION PROJECT AND RELATED PROJECTS

Studies have concluded that the permeable soils and geologic formations within and around the Dutch Slough Restoration Project site would allow for potentially significant subsurface hydraulic connectivity between the site and its surrounding properties (LSCE 2006). This connectivity would likely increase local groundwater elevations once the site is inundated by Delta waters, and create the potential for seepage into surrounding properties. The flattened gradient and elevated groundwater table on the Dutch Slough site following restoration suggests that there would be a greater magnitude and persistence of groundwater discharge into the Canal relative to existing conditions whenever groundwater elevations are greater than the Canal surface water elevation. As the tides within the Canal and on the Dutch Slough site are expected to be very close in magnitude but with a time lag in the Canal (LSCE 2006), the gradient would be expected to be quite small throughout much of the year leading to minimal net exchange. Winter rains, especially when combined with spring tides and large Delta outflow, may generate short-term increased gradients toward the Canal but the proposed tidal drainage versus current condition of storage with pump discharge is likely to remove rainfall via surface water more rapidly. Over the course of an annual cycle, the project would shift from a cycle of winter discharge into and summer recharge from the Canal at Emerson and Gilbert parcels, with the net direction being determined by tidal head (elevation) differences between Dutch Slough and Rock Slough (which the LSCE study states are negligible).

Therefore, any potential increase in salt loading into the Canal via groundwater discharge from Dutch Slough is likely to be small relative to current conditions. This impact, therefore, is likely to be less than significant. However, there is still some chance of an increase in salt loading occurring as a result of the Dutch Slough Restoration Project and thus mitigation measures are identified that would assure that this impact would be less than significant.

The planned encasement of the CCWD Canal, which is addressed further under Cumulative Impacts, would remove the risk of changes in groundwater levels on the project site affecting the water supply quality. That project also would protect the water supply from other potential sources of contamination such as agricultural runoff, municipal runoff, treated wastewater, and salt leaching from soils throughout the region. The CCWD project commenced implementation in 2008.

OPEN WATER MANAGEMENT OPTIONS

No change in impacts would occur with the various open water management options.

MITIGATION 3.1.1-5 GROUNDWATER INTRUSION STUDY AND REMEDIATION

If the Dutch Slough Restoration Project proceeds prior to the proposed CCWD Encasement Project, then the Dutch Slough Restoration Project shall participate in a study with CCWD to quantify the relative contributions of all possible sources of salt loading into the Canal, thereby quantifying the relative role of the Dutch Slough Restoration Project in local groundwater intrusion. The Dutch Slough Restoration Project shall be responsible for components related to the Dutch Slough site; CCWD shall be responsible for addressing all other sources.

STUDY DESIGN

The study to be completed by the Dutch Slough Restoration Project shall determine the absolute and relative contributions/loadings of salt from the restored Dutch Slough Restoration Project site to the Contra Costa Canal during time periods when the CCWD Pumping Plant #1 draws Canal water for public drinking water supply. While CCWD's cooperation in this study cannot be required under CEQA, it would increase greatly the likelihood of correctly identifying and quantifying other possible sources of salt loading to the Canal.

Salinity changes also could result from non-project activities including:

1. Groundwater pumping in the developed areas south of the Canal. Increased groundwater pumping would increase the gradient from the Canal to lands south of the Canal; that water demand could be met through increased inflows to the Canal at Rock Slough or it could cause a steeper groundwater gradient from the Project area than would otherwise exist, thereby increasing the potential for salt transport into the Canal from the Project area.

2. Changes in the salinity of inflow water at Rock Slough, a condition driven by more regional Delta salinity conditions.

Thus, in order to establish salinity effects from the Project area, the analysis will have to incorporate continuous salinity monitoring data from other nearby Delta locations or, if such monitoring locations are not already in place, such monitoring will have to be added into this study.

The study shall consist of an expanded version of that prepared by LSCE (2006). It shall reoccupy existing wells and install new wells to establish an adequate monitoring framework spatially and with depth, north and south of the Canal and explicitly capturing potential salt loading areas such as the Ironhouse Sanitary District lands. Monitoring shall include Canal surface water and Dutch Slough Restoration Project and other groundwater levels and conductivity utilizing automated sensors at tidal time-scale frequencies (12 or 15 minute intervals, depending on whether we track DWR or NOS monitoring). In addition, water quality grab samples shall be collected periodically (roughly biweekly) and analyzed for indicator trace minerals. If viable, the study shall also include use of added tracers for the purpose of establishing groundwater transport patterns. The monitoring shall occur for one year prior to opening the Dutch Slough Restoration Project to tidal action and continuing for one year afterwards. The study shall be operated under an approved Quality Assurance Project Plan (QAPP) to ensure collection of high-quality data upon which conclusions will be based.

Data analysis shall include using water levels to establish groundwater discharge-recharge conditions, conductivity to contribute to salt transport analyses, and trace mineral and potentially added tracers to establish salt loading sources and directions of transport. Analyses of other data sources shall also be included, such as soils maps to identify regions that could leach salts, and prior groundwater level and quality data to provide a broader perspective and to capture whether conditions during the study were reflective of or unique from prior conditions.

POST-STUDY ACTIONS

The data from this study shall be used to determine if groundwater intrusion from the Project area would result in an unacceptable increase in salinity in the Canal. The performance criteria for salinity are based on the guidelines set forth in the Bay-Delta Plan (SWRCB 2006). The Plan states that the maximum mean daily concentration of chloride (Cl^-) shall not exceed 250 mg/L during any "water year type" (defined by the Sacramento Valley 40-30-30 water year hydrologic classification index). In addition, the maximum mean daily concentration of 150 mg/L Cl shall be maintained for at least 240 days during a wet year, 190 days during an "above normal" year, 175 days during a "below normal" year, 165 days during a "dry" year, and 155 days during a "critical" year.

The project will be considered responsible for significant impacts to water quality only if, following restoration, (1) there is an increase in the groundwater gradient from the Project area into the Canal and (2) this change in gradient is accompanied by an unacceptable (as defined above) increase in salinity in the Canal water that is attributable to the increased groundwater gradient from the Project area.

If there is an increase in salinity in the Canal attributable to the Project and simple modifications to operations at the CCWD Water Treatment Plant to prevent violations of the salinity standards and maintain water supply to CCWD customers are determined to be infeasible by CCWD, one of the following mitigations shall be implemented:

1. Implementation of the Dutch Slough Restoration Project shall be delayed until the CCWD has encased the drinking water supply within the Canal in a pipeline.

or,

2. The technical and economic feasibility of constructing a groundwater cutoff wall (slurry wall), toe drain and pump, or other effective means of reducing infiltration into the Canal shall be evaluated, and such measures shall be implemented as appropriate. The groundwater intrusion study described above shall be continued after the implementation of the mitigation measures to determine the effects on groundwater infiltration and salinity in the Canal. The mitigation measures shall be deemed successful when salinity levels in the Canal are reduced below the threshold levels described above.

IMPACT SIGNIFICANCE AFTER MITIGATION

Less than significant with mitigation.

IMPACT 3.1.1-6 GROUNDWATER INTRUSION ONTO ADJACENT PARCELS

DUTCH SLOUGH RESTORATION PROJECT AND RELATED PROJECTS

Connectivity of the shallow aquifer suggests that permanently raised Dutch Slough Restoration site groundwater levels would have some influence on groundwater intrusion in all directions. These effects would be tempered to a great degree, however, because the tidal sloughs separating the restoration site from its adjacent parcels to the north, west, and south exert a far stronger hydraulic signal on groundwater (Hultgren-Tillis 2005). Groundwater pumping on these adjacent properties steepens the hydraulic gradient, causing greater flow from the Dutch Slough site. Adjacent parcels to the east and, if the Contra Costa Canal is encased, to the south, could therefore have increased pumping volumes, especially outside the wet season when other contributing sources to groundwater diminish relative to the possible Dutch Slough contribution.

North. Dutch Slough to the north is a wide, deep channel with a relatively large daily flow and direct hydraulic connection via sandy soils underlying the levees for Jersey Island to the north and the Dutch Slough site to the south (Hultgren-Tillis 2005). Groundwater effects of the Dutch Slough Restoration Project to Jersey Island are likely to be insignificant, therefore, and it is doubtful whether their signal could be detected amongst all the other controls on Jersey Island groundwater, i.e., the “noise” in the groundwater signal.

South. The Contra Costa Canal to the south has tides nearly identical to those at Emerson slough, and recent data demonstrate the tidal connectivity to groundwater on both sides of the Canal (LSCE 2006). Two external changes may take place in the near future, either before or after Dutch Slough implementation. First, a proposed residential development south of the Canal that is partially below sea level intends to install and permanently operate a groundwater management infrastructure system. Though groundwater on that property is currently pumped, the new system would be operated to maintain a lower and consistent groundwater level that will act to steepen the hydraulic gradient to its north, towards the Canal and Dutch Slough site. Under the current Canal configuration, increased groundwater levels at the Dutch Slough site would be dampened by the Canal such that the restoration site’s groundwater signal to this property would be reduced to the level of insignificance.

Second, the Contra Costa Water District has proposed to fill the Canal, thereby eliminating the Canal’s influence on groundwater levels south of the Dutch Slough site. Under this scenario, tidal action within the Dutch Slough Project would replace the Canal's influence to groundwater south of the Canal. Because of the greater horizontal distance between Dutch Slough and the property to the south and because backfill soils in the Canal reduce hydraulic conductivity relative to open water of the Canal, there would be lower hydraulic gradients relative to the existing condition and thus this impact would be less than significant.

West. Marsh Creek to the west is fully tidal to the EBRPD bridge with minor tidal dampening south to the Canal (NHI 2002). Ironhouse groundwater data (as reported in PWA 2006) also shows a strong tidal signal, with average levels (mean tide level) similar to those expected at the Dutch Slough Restoration Project site. During most of the year, no detectable changes in groundwater levels are expected to the west (Hultgren-Tillis 2005). During winter storm periods, prolonged average tide levels and higher peak high tides associated with storms may increase groundwater levels a small amount relative to existing conditions (Hultgren-Tillis 2005), thereby reducing by a small amount the absorption capacity of the field to the west currently irrigated with treated wastewater by the Ironhouse Sanitary District. The magnitude of this potential effect, however, is likely to be low since groundwater levels on remaining Ironhouse irrigated lands will be similar to the restored marsh and existing conditions primarily because Ironhouse does not pump its groundwater (i.e., a relatively small gradient). Due to projected increases in treatment demand associated with residential growth in the area, ISD is undertaking expansion plans that include terminating irrigation of these fields by 2010, before implementation of the Dutch Slough Restoration Project (Tom Williams, personal communication, July 3, 2008). Termination of irrigation would eliminate this impact west of the Dutch Slough Project site and no mitigation would be required.

East. To the east across Jersey Island Road are continued diked, subsided lands proposed for residential development; no tidal slough divides these properties. Dutch Slough Restoration Project site groundwater level increases are likely to increase groundwater flux to the east, requiring additional pumping to maintain existing water levels. This effect is likely to be significant. The Dutch Slough Restoration Project includes construction of a new levee on the west side of Jersey Island Road (PWA 2006). The proposed Hotchkiss development to the east intends to use groundwater as a resource to support water feature amenities and it includes a toe drain east of the new levee. If that project proceeds, then the impact is likely not to be significant. If Hotchkiss development does not proceed, then the impact would remain significant and require mitigation by the Dutch Slough Restoration Project, as identified in Mitigation 3.1.1-6-2, below.

OPEN WATER MANAGEMENT OPTIONS

The more open water area in the project, the greater influence the project would have on adjacent groundwater levels because open water transmits water level changes more rapidly and to a greater degree than do soils. If open water areas are managed as tidal systems, the groundwater fluctuations would be similar to those associated with tidal marsh components of the project, but with slightly greater changes in water levels and shorter durations of each of the water-level changes. The impacts to groundwater on adjacent parcels would be less than significant since none of the proposed open water areas would directly border the adjacent parcels (i.e. adjacent parcels are all bordered by either large stretches of land [that would buffer them from effects of open water management], or existing tidal sloughs).

If the open water areas are managed as a pond system, water surface elevations would be controlled by structures such as tide-gates and culverts. The effects of a managed pond regime on groundwater seepage onto adjacent parcels would depend on ultimate water surface elevations within the ponds, which could be managed lower or higher than tidal open water. The significance of the seepage impact would depend on the management regime (higher surface elevations would have a greater potential to result in groundwater intrusion on adjacent parcels).

"NO BURROUGHS" OPTION

If this option were exercised, there would be no tidal marsh on the easternmost project parcel (Burroughs), so the risk of groundwater flux to the east would be negligible. This would eliminate a potentially significant impact, and Mitigation 3.1.1-6.2 would not be necessary.

MITIGATION 3.1.1-6.1 GROUNDWATER INTRUSION PROTECTION: WEST OF DUTCH SLOUGH RESTORATION PROJECT SITE

ISD is implementing treatment alternatives that will eliminate use of the parcels adjacent to the Dutch Slough Restoration Project for treated wastewater irrigation. If the Dutch Slough Restoration Project proceeds before the Ironhouse Sanitary District (ISD) discontinues irrigation of its fields near its treatment plant (immediately west of the Ironhouse Project site) and if irrigation is expected to continue after Dutch Slough implementation, then the following mitigation measure shall be implemented:

CONTINUED GROUNDWATER MONITORING

The ISD currently monitors the groundwater levels in its irrigation fields manually once a month using a grid of 19 wells. The water level in the Contra Costa Canal adjacent to the Oakley treatment plant is also recorded at the time of the monthly monitoring by surveying the water surface elevation from a nearby benchmark. This monitoring program shall continue after the implementation of the Dutch Slough Restoration Project. In addition to the existing monitoring plan, the water level in Marsh Creek shall be surveyed during each monitoring event. Water level monitoring at Marsh Creek shall begin at least a year before restoration activities begin.

The Dutch Slough Restoration Project shall coordinate with the ISD to review pre- and post-restoration groundwater monitoring data to determine whether restoration activities at Dutch Slough are leading to increased groundwater levels and reduced groundwater storage capacity on the Ironhouse irrigation fields.

If there is an increase in groundwater levels at the Ironhouse irrigation fields that can be attributed to the Dutch Slough Restoration Project following the restoration activities and the increased groundwater levels cause a significant loss of groundwater storage capacity resulting in the loss of the use of the site for treated wastewater irrigation by ISD, the following additional mitigation measure shall be implemented.

DEVELOP COMPENSATORY PROGRAM WITH THE ISD

The DWR shall coordinate with the ISD to determine the costs incurred to pump additional water to the District's Jersey Island lands as a result of restoration activities. One way in which this could be accomplished is by determining the volume of groundwater storage capacity that is lost following restoration and paying for the disposal of this volume of water. The exact formula for determining this volume, and the appropriate disposal costs shall be determined jointly by DWR and the ISD.

MITIGATION 3.1.1-6.2 GROUNDWATER INTRUSION PROTECTION– EAST OF SITE

The Dutch Slough project shall participate in a joint study with the adjacent landowners to the east to quantify the relative contributions of all possible sources of groundwater intrusion into the parcels east of the restoration site, thereby quantifying the relative role of the Dutch Slough restoration project in contributing to groundwater pumping needs. This study shall include field monitoring to measure actual flux into the eastern parcel. If this study determines a significant contribution from the project that would adversely affect hydrologic conditions east of the site that cannot be addressed with existing or planned groundwater management systems, then the technical and economic feasibility of constructing an effective means of reducing flux into the parcels shall be evaluated. Measures may include a groundwater cutoff wall, toe drain, or financial contribution to the operations and maintenance of groundwater collection systems currently in place or anticipated to be in place with new residential development, at levels commensurate with the documented percent contribution of the Dutch Slough project to increased groundwater levels and volumes to the south requiring abatement.

MITIGATION 3.1.1-6.3 DELAY DUTCH SLOUGH RESTORATION PROJECT UNTIL CESSATION OF IRRIGATION ON IRONHOUSE PARCELS AND CONSTRUCTION OF JERSEY ISLAND ROAD LEVEE

As an alternative to Mitigations 3.1.1-6.1 and 3.1.1-6.2 above, to prevent the loss of irrigation capacity at the Ironhouse parcels and the potential for groundwater intrusion onto the Hotchkiss Tract, to the east of the Dutch Slough Restoration Project site, implementation of the Dutch Slough Restoration Project shall be delayed until the ISD no longer uses lands west of the Dutch Slough site for wastewater irrigation and the Jersey Island Road levee/groundwater collection system is constructed.

IMPACT SIGNIFICANCE AFTER MITIGATION

Less than significant with mitigation.

IMPACT 3.1.1-7 WIND-WAVE DRIVEN LEVEE OVERTOPPING INTO CONTRA COSTA CANAL

DUTCH SLOUGH RESTORATION PROJECT AND RELATED PROJECTS

The levee along the north side of the Contra Costa Canal adjacent to the Project site has top elevations that range from +8.3 to over +24 ft NGVD29. Though the portion of this levee adjacent to the Emerson parcel has top elevations above +12 ft NGVD29, the portion of the levee adjacent to the Gilbert and Burroughs parcel is generally lower, with top elevations between +8.3 and +11.7 ft NGVD29. The low point (+8.3 ft NGVD29) in the levee south of the Gilbert parcel is only 1.8 ft above the 100-year tide level of +6.5 ft NGVD29.

There are two conditions when overtopping might occur. Both conditions are associated with extreme high tide events, which can occur in winter (Dec-Jan) and summer (Jun-Jul). In addition, Delta water levels can be much higher in the winter during major storm runoff events, a condition that does not occur in the summer. Significant wind events tend to come from the south during winter storms, away from the Canal, and from the west to northwest in the summer, somewhat aligned with the southern boundary. Were overtopping to occur in the winter, no significant impact is presumed to occur due to ambient salinity within the Dutch Slough site being very similar to that of the Canal water. Were overtopping to occur in the summer, a potentially significant effect on salinity in the Canal water could occur if the Canal were being used for water supply conveyance.

OPEN WATER MANAGEMENT OPTIONS

No change in impacts would occur with the various open water management options.

MITIGATION 3.1.1-7 LEVEE OVERTOPPING STUDY AND CONSTRUCT LEVEE IMPROVEMENTS OR DELAY DUTCH SLOUGH IMPLEMENTATION SCHEDULE IF OVERTOPPING A CONCERN

If the Dutch Slough Restoration Project proceeds prior to the proposed CCWD Encasement Project, then the Dutch Slough Restoration Project shall conduct a study to quantify the risk of upland/berm overtopping into the Contra Costa Canal and implement protective actions, as described below.

STUDY DESIGN

Factors in the study design are (1) existing elevations of land between the southern boundary of Dutch Slough and the Contra Costa Canal, (2) proposed land elevations of the encasement project, (3) 100-year tide heights, (4) wind fetch distance within Dutch Slough restoration site, (5) width of emergent vegetation between open water areas of restoration site and southern end of restoration site (emergent vegetation is a significant wave attenuator), and (6) projected wind-wave run-up heights in light of wind fetch distance and emergent vegetation wave attenuation effects.

DWR shall obtain detailed topographic data of the upland portions of the restoration parcels that border the Canal, as well as data along the northern Canal berm adjacent to the project area. Topographic data for the Project site already exists (PWA 2006); the CCWD should be able to supply topographic data for the Canal berms.

These topographic data shall be used to create a focused Digital Elevation Model (DEM) of the area bordering the Canal, which will be compared to the tidal datums calculated for the Project to determine if there are any areas along the Canal that may overtop under the anticipated typical range of tides and storms. Also, long term water level data shall be obtained from the nearby DWR Rock Slough monitoring station to look for past extreme high water events that, if replicated in the future, could potentially overtop the lands surrounding the Canal. Ten years of historic data shall be investigated. The most important events to look for are those that occur during low-flow (i.e. brackish) conditions in the Delta, since these brackish flows would have the greatest potential impact on water quality in the Canal.

If the study identifies events that could potentially overtop the levees surrounding the canal if replicated in the future, and these events are likely to be frequent (more than once per year), and likely to occur during periods of elevated Delta salinity, either of the following mitigation approaches shall be implemented:

A. CONSTRUCT ADDITIONAL LEVEE OR PERFORM LEVEE IMPROVEMENT IN POTENTIAL PROBLEM AREAS

If this study determines a significant likelihood of overtopping that would adversely affect water quality in the Canal, then levee structures/enhancements shall be constructed along the south boundary of the Dutch Slough Restoration Project as part of the Dutch Slough Project. The design of the structures/enhancements shall be based on the results of the study outlined above and shall include considerations for sea-level rise. Levee improvements must be approved by FEMA, Reclamation District 799 and the US Army Corps of Engineers. Should the overtopping only occur in isolated areas, levee construction or enhancement should be focused in those areas, rather than lining the entire southern boundary of the site.

B. Delay Dutch Slough Restoration Project Until CCWD Encasement Project Is Complete

If this study determines a significant likelihood of overtopping that would adversely affect water quality in the Canal, then the second option is to delay implementation of the Dutch Slough Restoration Project until the CCWD has encased the drinking water supply within the Canal in a pipeline.

C. Provide Flood Protection to Adjacent Properties after Canal Encasement

Once the Contra Costa Canal is encased, the height of the berm will be reduced. If this study determines a significant likelihood that the restoration project would cause flooding over the encased canal and onto properties to the south of the project, then the project design would be changed to incorporate a berm or levee sufficient to protect those areas from flooding.

Impact Significance After Mitigation

Less than significant with implementation of either of the above mitigation measures.

Impact 3.1.1-8 Insufficient Sedimentation in New Wetland Basin

Dutch Slough Restoration Project and Related Projects

Under Alternative 1, the Dutch Slough site would start at the lowest initial elevation, requiring the greatest amount of subsidence reversal to achieve intertidal marsh elevations. Accretion can occur through mineral deposition and biomass accumulation (plant matter). Mineral sedimentation rates are expected to be relatively low (PWA 2006), thereby leading to long time periods over which the restored marsh is expected to form. Plant biomass accumulation can be aided through management efforts, which is the general idea behind the open water management options described below. Because the site is expected to meet all its mitigation requirements with the as-built elevations, no adverse impact is expected from insufficient sedimentation. However, it will be critical that the project establish realistic sedimentation expectations based on sound scientific data from other San Francisco Bay-Delta area projects, in order to ensure that the evaluations of its outcome are judged against appropriate rather than unrealistic milestones.

It should be noted that even the highest rates of natural sedimentation processes may or may not be able to keep up with global/local sea level rise. A number of features that are likely to minimize the impact of sea-level rise on marsh restoration and its physical evolution have been incorporated into project design. These features include:

- Construction of a gradually sloping marsh surface (i.e., the terrestrial ecotone along grassland edges) that provides an elevation gradient over which elevation zones of tidal marsh may shift upslope as sea level rises;

- Early initiation of marsh vegetation ("pre-vegetation" of managed nontidal freshwater marsh, subsidence reversal, during construction) to maximize the duration of tule growth and establishment, marsh elevation gain, and biomass accumulation before excessive sea level rise acceleration may occur.

- The project's external levees will be designed to ensure that they can be adapted to anticipated Sea Level Rise. Current projections predict that SLR in this area will be between 6 and 13 inches over the next 50 years. Levee design (sizing and construction) will provide protection against this level of SLR; future levee work will ensure enhanced protection if projections are adjusted upward.

OPEN WATER MANAGEMENT OPTIONS

The intent of the open water management options is to test different approaches to facilitating plant biomass accumulation leading to intertidal elevations, to provide suitable fish habitats constrained by low initial starting elevations, and to provide some flexibility in how portions of the site are managed. Sediment supply should be greater with tidal versus managed options as there would be the greatest exchange with the source supply. Biomass accumulation depends on species present and the inundation regime (depth, frequency, duration) that exerts control over the many processes that affect production and decomposition. Tidal options may prove too deep in some areas and non-tidal is intended to provide some control to promote biomass accumulation. Actual differences would depend on many details about project operations not known at this time. The skeletal channel network option should act reasonably similar to the tidal option within the channel and similar to the non-tidal option outside the channel.

IMPACT SIGNIFICANCE

Impact significance would depend on the rate of sea level rise and accretion, the significance of this impact is uncertain and speculative at this time.

IMPACT 3.1.1-9 LIMITED PERSISTENCE OF SHALLOW TIDAL MARSH CHANNELS

DUTCH SLOUGH RESTORATION PROJECT AND RELATED PROJECTS

Vegetation such as tules (*Schoenoplectus acutus* or *S. californicus*) would tend to dominate and fill in shallow tidal marsh channels (i.e., those channels with invert elevations around MLLW and higher) in many Delta wetlands. Vegetation infilling can but does not always lead to the channel disappearing as a geomorphic feature. However, it does reduce water exchange and it limits access to aquatic organisms into the channel and any marsh areas upstream of the vegetation. Such infilling, therefore, can detrimentally affect the ecological outcomes of the restoration effort.

OPEN WATER MANAGEMENT OPTIONS

No change in impacts to shallow tidal marsh channels would occur with the various open water management options.

MITIGATION 3.1.1-9 CHANNEL DESIGN

The invert elevation of any channels meant to persist as open-water habitat shall be designed to be at least 20 cm below MLLW. This depth would prevent emergent vegetation from filling in the channels. It should be noted that depths significantly greater may present adverse conditions for target fish species; see Chapter 3.5, *Aquatic Biology,* for information on appropriate maximum depths.

IMPACT SIGNIFICANCE

Less than significant with mitigation

Alternative 2: Moderate Fill

IMPACT 3.1.2-1 EROSION IN TERMINAL SLOUGHS DUE TO INCREASED TIDAL PRISMS

DUTCH SLOUGH RESTORATION PROJECT, RELATED PROJECTS AND ALL OPTIONS

Same as Impact 3.1.1-1 above, except that the larger amount of fill would result in smaller tidal prisms and therefore less erosion in the terminal sloughs. Erosion in the terminal sloughs would not be affected by the different Marsh Creek relocation options.

MITIGATION 3.1.2-1 (.1 AND .2)

Same as Alternative 1.

IMPACT SIGNIFICANCE AFTER MITIGATION

Less than significant with mitigation

IMPACT 3.1.2-2 DECREASED FLOOD FLOW CONVEYANCE OF MARSH CREEK DUE TO INCREASED TAILWATER ELEVATIONS

DUTCH SLOUGH RESTORATION PROJECT, RELATED PROJECTS, AND ALL OPEN WATER MANAGEMENT OPTIONS

Same as Impact 3.1.1-2 above. If restoration of the Ironhouse parcel or relocation of the Marsh Creek delta do not occur, this impact would not apply. Flood flow conveyance in Marsh Creek would not be affected by the different open water management options.

MARSH CREEK DELTA RELOCATION

As detailed below, the various Marsh Creek delta relocation options (see Figure 2-13) would have different effects on flood flow conveyance in Marsh Creek by changing the degree to which the tidal signal moves upstream and by how fluvial sediment and debris are transported once reaching tidal waters (see further impacts below). As discussed above, there is currently little tidal dampening between the mouth of Marsh Creek and near where it crosses the Contra Costa Canal due to the large channel north of the EBRPD bridge. The projected impacts of the different relocation options described below assume that all Marsh Creek delta relocation options involve the construction of tidal channels that can handle at least the 100-year design flow rate for the ultimate watershed development, per CCCFCWCD.

Options 1 and 2. As with restoration of the Ironhouse parcel, diversion of Marsh Creek into the Dutch Slough Restoration Project site at the locations shown in the Conceptual Plan and Feasibility Report (PWA 2006) would propagate a 0.2 ft higher MHHW farther upstream south of the Contra Costa Canal crossing compared to current conditions. Again, although the effects of this tailwater increase are unlikely to be significant, modeling the effects is recommended (see Mitigation Measure 3.1.1-2.1).

Option 3. No change in Marsh Creek flood conveyance is anticipated because the diversion into Dutch Slough is expected to be far enough downstream and large enough such that changes in tailwater elevations are not expected (PWA 2006).

Mitigation 3.1.2-2.1 Develop Design Criteria for Increased Tidal Prism on Marsh Creek

Same as Mitigation 3.1.1-2.1 above except that the hydrodynamic modeling analysis shall include the Marsh Creek relocation options.

Mitigation 3.1.2-2.2 Design Marsh Creek to Convey 100-year Design Flow

Same as Mitigation 3.1.1-2.2 above.

Impact Significance After Mitigation

Less than significant with mitigation

Impact 3.1.2-3 Point Bar Formation in Marsh Creek

Dutch Slough Restoration Project and All Open Water Management Options

No impact.

Marsh Creek Delta Relocation

For each of the three Marsh Creek delta relocation options, the point of diversion would create an angular turn of flow which may in turn lead to point bar creation. Point bars would primarily accrete from sediment delivered by the watershed though reworking of restored marsh sediments could occur especially in the early years. Point bars could potentially grow large enough to reduce the flood flow conveyance of the channel.

Mitigation 3.1.2-3 Channel Design and Monitoring

The new Marsh Creek channel shall be designed to have excess width at the point of diversion into the Dutch Slough basin to reduce the likelihood of point bar formation negatively impacting flood conveyance in the channel. This channel shall be monitored by the Project for at least 10 years post-restoration to allow for possible dredging and other maintenance activities to maintain an adequate cross-section.

Impact Significance After Mitigation

Less than significant with mitigation.

Impact 3.1.2-4 Sedimentation in Tidal Portion of Relocated Marsh Creek Channel

Dutch Slough Restoration Project and All Open Water Management Options

No impact.

Marsh Creek Delta Relocation

Sedimentation within the new tidal marsh channel created by each of the three Marsh Creek delta relocation options may adversely affect the 100-year design flow conveyance of the channel.

MITIGATION 3.1.2-4.1 CHANNEL DESIGN AND MONITORING

The Marsh Creek channel downstream of the diversion into the Dutch Slough site shall be sized for at least the 100-year design flow of Marsh Creek. Compared to existing conditions, this design channel is likely to gain scour from the tidal prism of the adjacent marsh plain to maintain channel geometry, whereas the current channel north of the EBRPD bridge is confined by levees.

Monitoring of the tidal portion of the new Marsh Creek channel shall be performed at least yearly for five years minimum to ensure that sedimentation is not negatively affecting flood flow conveyance. This monitoring shall include regularly-spaced (maximum interval of 500 feet) cross-section surveys and a thalweg survey. Additionally, monitoring the original six channel cross-sections established by NHI in 1999 (NHI 2002) shall be conducted to allow for detection of sedimentation farther upstream from the new channel.

IMPACT SIGNIFICANCE AFTER MITIGATION

Less than significant with mitigation.

IMPACT 3.1.2-5 PEAK FLUVIAL-TIDAL DEPOSITION

DUTCH SLOUGH RESTORATION PROJECT AND ALL OPEN WATER MANAGEMENT OPTIONS

Same as Alternative 1.

MARSH CREEK DELTA RELOCATION

As with the Dutch Slough Restoration Project, due to increased tailwater elevations in Marsh Creek from relocation of the Creek's delta (see Impact 3.1.1-2 above), the point of peak tidal-fluvial deposition in the creek would move south (upstream). From a qualitative perspective, considering the anticipated small (0.2 ft) increase in MHHW throughout the lower reach of Marsh Creek, WWR expects that the depositional changes would be less than significant. The CCC Flood Control District may have to shift the location, extent, and frequency of channel bed dredging as a consequence of this project, but it is not expected to result in a significant change to dredging needs.

IMPACT SIGNIFICANCE

Less than significant. No mitigation is required.

IMPACT 3.1.2-6 IN-KIND LEVEE REQUIREMENTS AT THE IRONHOUSE PROJECT PARCEL (IRONHOUSE PROJECT ONLY)

Same as Alternative 1.

MITIGATION 3.1.2-6. CONSTRUCT FLOOD PROTECTION LEVEE AROUND IRONHOUSE PARCEL (IRONHOUSE PROJECT ONLY)

Same as Alternative 1.

IMPACT SIGNIFICANCE AFTER MITIGATION

Less than significant with mitigation

IMPACT 3.1.2-7 POSSIBLE WATER QUALITY DEGRADATION IN CONTRA COSTA CANAL DUE TO GROUNDWATER SEEPAGE

DUTCH SLOUGH RESTORATION PROJECT AND ALL OPTIONS

Same as Alternative 1.

MITIGATION 3.1.2-7 GROUNDWATER INTRUSION STUDY AND REMEDIATION

Same as Alternative 1.

IMPACT SIGNIFICANCE AFTER MITIGATION

Less than significant with mitigation.

IMPACT 3.1.2-8 GROUNDWATER INTRUSION ONTO ADJACENT PARCELS

DUTCH SLOUGH RESTORATION PROJECT AND OPEN WATER MANAGEMENT OPTIONS

Same as Alternative 1, Impact 3.1.1-6.

MARSH CREEK DELTA RELOCATION

Relocating the Marsh Creek delta may lessen the effect of groundwater seepage at the northeast corner of the Ironhouse parcel, but not significantly.

MITIGATION 3.1.2-8

Same as Alternative 1, Mitigation 3.1.1-6.

IMPACT SIGNIFICANCE AFTER MITIGATION

Less than significant with mitigation.

IMPACT 3.1.2-9 WIND-WAVE DRIVEN LEVEE OVERTOPPING OF SOUTHERN UPLANDS INTO CONTRA COSTA CANAL

DUTCH SLOUGH RESTORATION PROJECT AND ALL OPTIONS

Same as Alternative 1 (Impact 3.1.1-7), except that the maximum wind-wave height may be lower due to the higher tidal marsh elevations and greater distance of the Canal from open water resulting from the increased amounts of fill placed on the site. No change in impacts would occur with the various Marsh Creek delta relocation options.

MITIGATION 3.1.2-9

Same as Alternative 1, Mitigation 3.1.1-7.

IMPACT SIGNIFICANCE AFTER MITIGATION

Less than significant with mitigation.

Impact 3.1.2-10 Insufficient Sedimentation in New Wetland Basin

Dutch Slough Restoration Project and All Open Water Management Options

Same as Alternative 1 (Impact 3.1.1-8), except that the increased amount of fill under Alternative 2 would require less sedimentation across the site.

Marsh Creek Delta Relocation

Insufficient sedimentation in the Emerson Parcel may delay the evolution of an intertidal channel network linked to a new, relocated Marsh Creek delta.

Impact Significance

Potentially significant and unmitigable, depending on rate of sea level rise.

Impact 3.1.2-11 Limited Persistence of Shallow Tidal Marsh Channels

Dutch Slough Restoration Project and all Options

Same as Alternative 1.

Mitigation 3.1.2-11 Channel Design Considerations

Same as Alternative 1.

Impact Significance After Mitigation

Less than significant with mitigation.

Alternative 3: Maximum Fill

Impact 3.1.3-1 Erosion in Terminal Sloughs Due to Increased Tidal Prisms

Dutch Slough Restoration Project

Similar to Impact 3.1.1-1 above, except that the maximum amount of fill would result in smaller tidal prisms and likely smaller quantities of erosion.

Open Water Management Options

Similar to Impact 3.1.1-1 above, except that the larger amount of fill would result in smaller tidal prisms and likely smaller quantities of erosion.

Marsh Creek Delta Relocation

Erosion in the terminal sloughs would not be affected by the different Marsh Creek relocation options.

Mitigation 3.1.3-1

Same as Alternative 1.

Impact Significance After Mitigation

Less than significant with mitigation.

Impact 3.1.3-2 Decreased Flood Flow Conveyance of Marsh Creek Due To Increased Tailwater Elevations

Dutch Slough Restoration Project and all Options

Same as Alternative 1.

Mitigation 3.1.3-2.1 Develop Design Criteria for Increased Tidal Prism on Marsh Creek

Same as Mitigation 3.1.1-2.1 above except that the hydrodynamic modeling analysis shall include the Marsh Creek relocation options.

Mitigation 3.1.3-2.2 Design Marsh Creek to Convey 100-year Design Flow

Same as Mitigation 3.1.1-2.2, above.

Impact Significance After Mitigation

Less than significant with mitigation.

Impact 3.1.3-3 Point Bar Formation in Marsh Creek

Dutch Slough Restoration Project and all Options

Same as Alternative 1.

Mitigation 3.1.3-3 Channel Design and Monitoring Considerations

Same as Alternative 1.

Impact Significance After Mitigation

Less than significant with mitigation.

Impact 3.1.3-4 Sedimentation in Tidal Portion of Relocated Marsh Creek Channel

Dutch Slough Restoration Project and all Options

Same as Alternative 1.

Mitigation 3.1.3-4 Channel Design and Monitoring

Same as Alternative 1.

Impact Significance After Mitigation

Less than significant with mitigation.

Impact 3.1.3-5 Peak Fluvial-Tidal Deposition

Dutch Slough Restoration Project and All Options

Same as Alternative 1.

Impact 3.1.3-6 Potential Increased Flood Hazards At the Ironhouse Parcel (Ironhouse Project Only)

Same as Alternative 1.

Mitigation 3.1.3-6 Construct Flood Protection Levee Around Ironhouse Parcel (Ironhouse Project Only)

Same as Alternative 1.

Impact 3.1.3-7 Possible Water Quality Degradation in Contra Costa Canal Due to Groundwater Seepage

Dutch Slough Restoration Project and all Options

Same as Alternative 1.

Mitigation 3.1.3-7 Groundwater Intrusion Study and Remediation

Same as Alternative 1.

Impact Significance after Mitigation

Less than significant with mitigation.

Impact 3.1.3-8 Groundwater Intrusion Onto Adjacent Parcels

Dutch Slough Restoration Project and all Options

Same as Alternative 1.

Mitigation 3.1.3-8

Same as Alternative 1.

Impact Significance After Mitigation

Less than significant with mitigation

Impact 3.1.3-9 Wind-wave Driven Levee Overtopping of Southern Uplands Into Contra Costa Canal

Dutch Slough Restoration Project and all Options

Similar to Alternative 1, except that the maximum wind-wave height would likely be minimized due to the presence of greater amounts of fill on the site, and the wind waves would have to propagate across a greater distance of higher elevation areas in the Gilbert and Burroughs parcels before reaching the canal. Thus, the level of impact would be less than Alternatives 1 or 2.

MITIGATION 3.1.3-9

Same as Alternative 1.

IMPACT SIGNIFICANCE AFTER MITIGATION

Less than significant with mitigation.

IMPACT 3.1.3.-10 INSUFFICIENT SEDIMENTATION IN NEW WETLAND BASIN

DUTCH SLOUGH RESTORATION PROJECT

The presence of greater fill on the site under this alternative minimizes the need for sedimentation from external sources. The Emerson parcel design is the same as for Alternative 2 and would still have an open water area in need of sedimentation. The Gilbert and Burroughs parcels would have no open water areas and thus would not experience significant effects of insufficient sedimentation.

OPEN WATER MANAGEMENT OPTIONS

The presence of greater fill on the site under this alternative eliminates open water areas from the Gilbert and Burroughs parcels and retains the same open water for the Emerson Parcel as under Alternative 2. Thus effects of insufficient sedimentation would be reduced.

MARSH CREEK DELTA RELOCATION

As the current proposal for grading on the Ironhouse parcel proposes grading down to intertidal elevations, instead of relying on sediment accretion to raise substrate elevations, this project component would not affect wetland basin sedimentation.

IMPACT SIGNIFICANCE

Potentially significant depending on rate of sea level rise.

IMPACT 3.1.3-11 LIMITED PERSISTENCE OF SHALLOW TIDAL MARSH CHANNELS

DUTCH SLOUGH RESTORATION PROJECT AND ALL OPTIONS

Same as Alternative 1.

MITIGATION 3.1.3-11 CHANNEL DESIGN CONSIDERATIONS

Same as Alternative 1.

IMPACT SIGNIFICANCE AFTER MITIGATION

Less than significant with mitigation.

Alternative 4: No Project

IMPACT 3.1.4-1 EROSION IN TERMINAL SLOUGHS

Under the No Project Alternative, tidal prisms at the site would not change. Therefore, erosion in the terminal sloughs would maintain its present equilibrium with sediment accretion in the sloughs.

IMPACT SIGNIFICANCE

No impact.

IMPACT 3.1.4-2 GROUNDWATER SEEPAGE INTO CONTRA COSTA CANAL

The 2006 study of groundwater characteristics within and around the Dutch Slough Restoration Project site by Luhdorff and Scalmanini Consulting Engineers discusses the fact that the Contra Costa Canal already experiences water quality degradation during periods of low flow (< 10 cfs), and hydraulic connectivity between the Canal and local groundwater is considered a primary source of degradation (LSCE 2006). The study concluded that groundwater flow into the Contra Costa Canal primarily happens on the Emerson and Gilbert parcels under the following conditions: (1) when groundwater levels exceed average tidal fluctuations, (2) during the wet season when groundwater is elevated above the level of surface water in the Canal, and (3) during the summer when irrigation of the site's existing fields causes groundwater to rise above the level of surface water in the Canal. Under the No Project Alternative, these conditions are expected to continue, so it follows that contamination of the drinking water supply in the Canal remains an impact of potential significance. However, as the Dutch Slough Restoration Project would not affect this continuation of existing conditions, no mitigation is required.

The encasement of the CCWD supply into a pipeline would remove the risk of groundwater contaminating the water supply. Such a pipeline would also protect the water supply from other potential sources of contamination such as agricultural and municipal runoff.

IMPACT SIGNIFICANCE

No impact.

Cumulative Impacts

The Dutch Slough Restoration Project site's location in a rapidly growing area of eastern Contra Costa County creates the potential for a number of impacts that, in conjunction with other nearby projects, could increase or decrease impacts. From a hydrologic and geomorphic perspective, the impacts of interest are those of flooding, groundwater seepage, and water quality.

IMPACT 3.1.5-1. GROUNDWATER SEEPAGE INTO THE CONTRA COSTA CANAL.

If CCWD proceeds with its water supply encasement project, then any groundwater seepage from the Dutch Slough Restoration Project into the canal and its associated introduction of brackish water would no longer affect drinking water quality. Consequently, the Project's potential impact to water supply would be eliminated by this cumulative project.

IMPACT 3.1.5-2. GROUNDWATER SEEPAGE INTO CYPRESS GROVE AND DUTCH SLOUGH PROPERTIES.

Cumulative projects include CCWD's plans to fill in and eliminate the Contra Costa Canal concurrent with encasing the water supply. This would result in groundwater flux to the south either remaining the same or decreasing for the reasons explained under Impact 3.1.1-6. Under current conditions, the Canal is a tidal water body that exerts a controlling factor on groundwater connectivity between lands to its north and south. The cumulative plus project conditions would result in a greater distance of tidal waters from these tracts than with the Canal. Therefore the project would not contribute to a significant cumulative impact to groundwater seepage on these parcels.

IMPACT 3.1.5-3 GROUNDWATER SEEPAGE AND TIDAL FLOODING EAST INTO HOTCHKISS TRACT

The potential for groundwater seepage and flooding onto the adjacent Hotchkiss Tract (Reclamation District 799) would be mitigated by the construction of a new Jersey Island Road levee and its associated toe drain. The new Jersey Island Road levee would have a toe/blanket drain on its landward side to remove any water that seeps through the levee from the Dutch Slough Restoration Project site (ENGEO 2005, Kleinfelder 2006). It would tie into an interior levee system needed on the Hotchkiss Tract to protect the new developments from flooding should the tract's unengineered exterior levees fail. Groundwater would also be pumped from the Hotchkiss Tract during the summer to provide "make-up" water for proposed stormwater retention/recreation ponds (ENGEO 2005). With this adjacent project, this impact is reduced to less than significant and no further mitigation is necessary.

IMPACT 3.1.5-4. TIDAL FLOODING SOUTH INTO CYPRESS GROVE AND DUTCH SLOUGH PROPERTIES

The CCWD's encasement project would lower the height of the existing canal barrier between the Dutch Slough site and properties to the south.

These adjacent properties to the south are either planning to build or are already constructing internal flood control levees similar to those on the Hotchkiss Tract should existing flood control levees around Dutch Slough and its tributaries fail. The Dutch Slough Properties Development site south of the Dutch Slough Restoration Project site plans to construct a 100-year internal flood control levee (City of Oakley 2005), and the Cypress Grove Development south of the Emerson restoration parcel has already constructed a 100-year internal flood control levee (PWA 2006). These planned new flood protection levees would reduce the potential for tidal flooding of the new residential areas from overtopping along the southern perimeter of the Dutch Slough Restoration Project to less than significant.

Undeveloped properties to the south of the encased canal could potentially be subject to flooding from wave-tide overtopping of the lowered encased canal berm. The likelihood and potential extent of this impact has not been calculated, however, any flooding of adjacent parcels by the Dutch Slough Restoration Project would be a potentially significant impact.

MITIGATION 3.1.5-4 CONDUCT FLOOD HAZARD STUDY AND CONSTRUCT FLOOD PROTECTION IMPROVEMENTS

As part of the levee overtopping study described in Mitigation 3.1.1-7, the Dutch Slough Restoration Project also shall evaluate the potential for flooding of unprotected lands south of the future encased canal. If that study indicates that there is the potential for the Project to increase flood hazards to those lands, then levee structures/enhancements shall be constructed along the south boundary of the Dutch Slough Restoration Project as part of the Dutch Slough Project. The design of the structures/enhancements shall be based on the results of the study outlined above and shall include considerations for sea-level rise. Should the overtopping only occur in isolated areas, levee construction or enhancement should be focused in those areas, rather than lining the entire southern boundary of the site.

IMPACT SIGNIFICANCE AFTER MITIGATION

Less than significant with mitigation.

IMPACT 3.1.5-5. EXCESS SCOUR IN EMERSON SLOUGH

The Cypress Grove development to the south proposes to discharge its stormwater runoff, after cycling through a treatment wetland and/or lake system, into Emerson Slough, which bisects the Restoration Project site (Balance Hydrologics 2004). Stormwater outflows from the Cypress Grove development are not expected to be large enough to change flow velocities in the channel, so erosion in Emerson Slough due to these flows is not anticipated to be an impact (Balance Hydrologics 2004). The Dutch Slough Restoration Project has designed locations of its breaches into Emerson and Gilbert Parcels to minimize the potential for excess scour in Emerson Slough.

IMPACT 3.1.5-6. EXCESS SCOUR IN LITTLE DUTCH SLOUGH

Stormwater from the Dutch Slough Properties development south of the site would likely be pumped into Little Dutch Slough. It may be necessary for that development project to be responsible for levee setbacks at the southern, comparatively narrow end of Little Dutch Slough to accommodate those additional flows. Such a levee setback would reduce the acreage of marsh restoration on the Gilbert and/or Burroughs parcels but it may also increase design flexibility for locating breaches along Little Dutch Slough. This impact is not significant and thus no mitigation is required.

Table 3.1-3: Summary of Hydrologic and Geomorphic Impacts for Dutch Slough and Related Restoration Projects

	Impact No.	Impact	Dutch Slough Restoration Project	Related Projects	
				Ironhouse Project	City Community Park Project
Alternatives 1, 2, and 3	3.1.1-1	Erosion in Terminal Sloughs Due to Increased Tidal Prisms	X		
	3.1.1-2	Decreased Flood Flow Conveyance of Marsh Creek Due To Increased Tail-water Elevations	X	X	
	3.1.1-3	Peak Fluvial-Tidal Deposition	X	X	
	3.1.1-4	Potential Increased Flooding At the Ironhouse Parcel		X	
	3.1.1-5	Possible Water Quality Degradation in Contra Costa Canal Due to Groundwater Seep-age	X		
	3.1.1-6	Groundwater Intru-sion Onto Adjacent Parcels	X	X	
	3.1.1-7	Wind-wave Driven Levee Overtopping Into Contra Costa Canal	X		X
	3.1.1-8 (3.2.2-10)	Insufficient Sedi-mentation in New Wetland Basin	X (minimized in Alt 3)	X	
	3.1.1-9 (3.2.2-12)	Limited Persistence of Shallow Tidal Marsh Channels	X	X	
	3.1.5-4	Cumulative Impacts: Tidal Flooding South of Contra Costa Canal	X		
Alternatives 2 and 3 only	3.1.2-3	Point Bar Formation in Marsh Creek	X		
	3.1.2-4	Sedimentation in Tidal Portion of Re-located Marsh Creek Channel	X		

Table 3.1-4: Summary of Mitigation Applicability for Dutch Slough and Related Restoration Projects

	Impact/Mitigation	Dutch Slough Restoration Project	Related Projects	
			Ironhouse Project	City Community Park Project
Alternatives 1, 2, and 3	Mitigation 3.1.1-1.1 Erosion/Sedimentation Performance Measures	X		
	Mitigation 3.1.1-1.2 Erosion Monitoring and Adaptive Management	X		
	Mitigation 3.1.1.2-1 Develop design criteria for increased tidal prism on Marsh Creek		X	
	Mitigation 3.1.1-2.2 Design Marsh Creek to Convey 100-year Design Flow	X	X	
	Mitigation 3.1.4-1 Construct flood protection levee around Ironhouse parcel		X	
	Mitigation 3.1.1-5.1 Groundwater Intrusion Study and Remediation	X		
	Mitigation 3.1.1-6-1 Groundwater Intrusion Protection: West of Site	X	X	
	Mitigation 3.1.1-6.2 Groundwater Intrusion Protection: East of Site	X		
	Mitigation 3.1.1-6.3 Delay Dutch Slough Restoration Project Until Cessation of Irrigation on Ironhouse Parcels and Construction of Jersey Island Road Levee	X	X	
	Mitigation 3.1.1-7 Levee Overtopping Study and Improvements or Delay Dutch Slough Restoration Project Until CCWD Encasement Project is Complete	X		X
	Mitigation 3.1.1-9 Channel Design	X	X	
	Mitigation 3.1.5-4 Conduct Flood Hazard Study and Construct Flood Protection Improvements			
Alternatives 2 and 3 Only	Mitigation 3.1.2-3 Channel Design and Monitoring	X		
	Mitigation 3.1.2-4.1 Channel Design and Monitoring	X		